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CONSERVATION TILLAGE UPDATE:

Keeping Soil Covered and Water Clean in the New Millennium

Data Update from Indiana's Clean Water Indiana Cropland Transect Surveys

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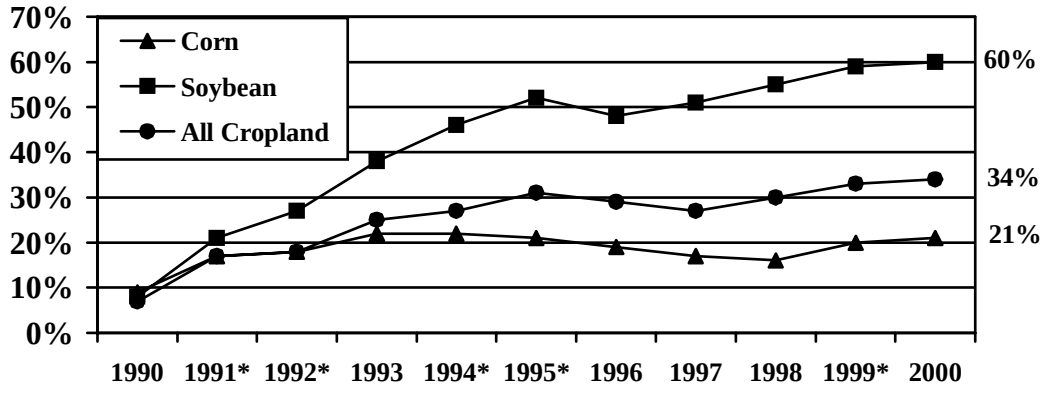
Clean Water Indiana Education Program **Purdue University, Agronomy Department**

This update provides a summary of trends associated with the adoption of no-till crop production, crop residue cover and soil loss. This data was obtained as a result of spring surveys of Indiana cropland. In an "average sized" Indiana county, a sample size of 450 crop fields produces a 95 percent level of confidence. [1] During the years 1990, 1993, 1996-1998, and 2000, the quantity of counties conducting the survey produced valid statewide results. All other years plotted or tabulated in this publication are estimates based on the scattered county input where surveys were conducted. Values reported are based on weighted averages to reflect differences in cropland acreage between counties. A total of 38,164 fields statewide were observed in 2000.

No-till Trends

No-till revolutionized the industry of agricultural production during the 1990s. Less than 10 percent of all cropland was managed in a no-till system in 1990. Initially, corn was considered the better adapted crop for no-till. In 1990, the percentage of crops managed in a no-till system were nine and eight percent for corn and soybean, respectively. By 1992, the curves for corn and soybean no-till adoption were diverging (Figure 1). Soybean were better adapted to the no-till environment than the corn hybrids of that time. Management skills for no-till corn were realized to be more demanding than for no-till soybean. The no-till drill facilitated a no-till soybean production boom. By 1995, Indiana became

Figure 1. Indiana No-till Adoption
(percent of cropland for specific crop by year 1990-2000)



** estimates based on limited number of counties surveyed*

the first corn-belt state to produce more than half of its soybean acres on no-till managed fields.

For the months April and May, Indiana climate data placed 1996 as the wettest (14.53") and 1997 as third coldest (51.5°F) on record. Such conditions hampered further gains in no-till adoption during both years. The percent of the Indiana corn crop grown in no-till fields peaked in 1993 at 22 percent. Until 1998, no-till corn maintained a slight but steady decline down to 16 percent. With better genetics, improved corn management techniques, adaptations like fall strip preparation, and more moderate spring weather, some producers found answers to their no-till corn concerns. Also sharp increases in diesel fuel prices during the spring of 2000 may have persuaded farmers to use no-till to cut fuel costs. As a result, no-till corn jumped 5 percent from 1998 to 2000. For the 2000 growing season, 21 percent of all Indiana corn acreage was planted no-till. Although at a slower pace than in the early 1990's, no-till soybean acreage continued its increase—up five percentage points during the 1998 to 2000 period. Of all Indiana soybean acreage, 60 percent was planted no-till in the 2000 growing season.

"No-till is without question the most effective conservation practice for reducing soil erosion and improving water quality."

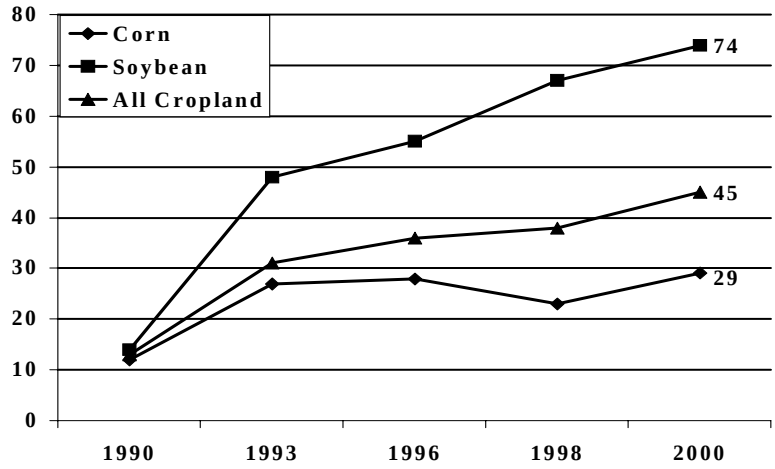
Much of the increased no-till adoption during the 1990s occurred on nearly level soils (0-2 percent slope). At the start of the decade, 54 percent of all no-till was on nearly level soils compared to 69 percent by 1998. During the 2000 growing season, 68 percent of the no-till acreage was on nearly level soil. By crop—in 2000, 60 percent of the no-till corn and 71 percent of no-till soybean were on nearly level soils. The 2000 corn and soybean no-till percentages on nearly level soils represent an increase of 8 and 14 percentage points respectively, when compared to 1990 data.

Conservation Tillage

Conservation tillage is defined as any tillage system leaving 30 percent or more crop residue cover on the soil surface after planting. No-till is without question the most effective conservation practice for reducing soil erosion and improving water quality. The crop residue cover and

Indiana Conservation Tillage Adoption

(percent cropland for specific crop in conservation tillage by year)



infiltration rates associated with no-till maximize the volume reduction of agricultural runoff and contaminants, when compared to other conservation tillage systems. Fall strip preparation (strip-till), vertical zone-till and residue fluffing rotary harrow systems achieve many of the benefits that are accomplished by pure no-till and are capable of meeting the definition of conservation tillage on more fragile soybean stubble. On corn stalks, conservation tillage could also include more aggressive tillage tools including but not limited to the use of a disk or field

Photo Courtesy of Conservation Technology Information

cultivator, narrow and minimal twist chisel plow with light secondary tillage, and a variety of other marketed and homemade tillage toolbars with assorted sweeps and disks. While not as efficient in conserving soil and reducing runoff as no-till, these more aggressive tillage practices, with proper management, can meet the definition of conservation tillage on corn stalks. There are few, if any, tillage tool options where a pass on soybean stubble can meet the definition of conservation tillage. The 30 percent soil cover that is achieved by conservation tillage is significant to reducing soil erosion by 50 percent or more compared to bare soil. Soil erosion and runoff are considered by volume the greatest contaminant of surface water in most Indiana watersheds. Conservation tillage was used on 29 percent of all corn acres and 74 percent of all soybean acres in 2000. Overall, conservation tillage was used on 45 percent of Indiana's cropland.

Filter strips, buffers and other conservation practices or structures alone cannot adequately protect soil from soil erosion . Nor can they reduce agriculture runoff and maximize their efficiency for improving water quality without the complement of conservation tillage.

Soybean Row Width

Filter Strips, Grassed Waterways or Buffers Alone are not sufficient for Improving Water Quality

Courtesy Putnam County Soil & Water Conservation District

A comparison of row width in soybean revealed that producers realized research supporting yield increases associated with drilled soybean when compared to wide rows. Drilled or narrow rows also canopy quicker, reducing soil loss. Of all no-till soybean, those soybean planted with a drill grew from 83 percent to 98 percent during the period 1990 to 1998. And of all drilled soybean, 61 percent was planted no-till in 1998, compared to 22 percent in 1990.

In the spring of 2000, a change in the survey technique separated row beans into two categories of narrow and wide. In 2000, 19 percent of the soybean were in rows with 7

Photo Courtesy Conservation Technology Information Center (CTIC)—Dan Towery

percent being in wide rows (>20" row spacing) and 12 percent in narrow rows (11"-20" row spacing). Drilled soybean (<10" row spacing) were the seeding method used for 81 percent of soybean planted in 2000. Of all drilled soybean, 67 percent were seeded using no-till. This continued increases from the 61 percent and 22 percent recorded in 1998 and 1990, respectively. No-till was used on 9 percent of wide row and 41 percent of narrow row soybean planted in 2000.

During most of the 1990s, stand establishment in soybean was moving from rowed to drilled. The change in 2000 survey procedures to track narrow soybean reflects observations of a trend back to rows, albeit narrow rows of 10 to 20 inches.

Rotational Tillage

Although Indiana has been a no-till adoption leader in the corn belt states, data suggests that few acres were no-tilled over the long term. For the years 1994-1999, eleven Indiana counties had conducted yearly tillage surveys making it possible to track rotational tillage (e.g. conventional crop followed by no-till crop) during this period. Of the 11 counties, Hendricks County's 3.3 years was the highest average continuous no-till for fields no-tilled in 1999. Allen County at 1.6 years had the greatest number of years of no-till prior to the year of tillage during the six-year period. Given that most research suggests the no-till benefits to soil physical property characteristics begin to appear no earlier than the third year of continuous no-till, it appears most farmers are abandoning no-till at about the time that one would expect to reap the soil physical property benefits associated with no-till. These benefits, over time, include but are not limited to improved infiltration, reduced runoff, increased earthworm activity, improved structure or tilth, and increased organic matter content.

Indiana Rotational Tillage Study [2]

Indiana Counties	Time 1999 Fields Have Been Continuous No-till (Average,	Years of No-till Prior to Tillage (Average, Years)
Hendricks	3.3	1.5
Randolph	2.9	1.5
Fountain	2.5	1.5
Kosciusko	2.2	1.4
Whitley	2.1	1.3
Montgomery	2.0	1.3
Allen	1.9	1.6
Rush	1.9	1.2
Clinton	1.8	1.3
Clay	1.7	1.2
Wabash	1.7	1.2

Current farm policy does not reward farmers who use no-till, or for that matter

Percent Corn Planted using a No-till System, Rank by County, 2000

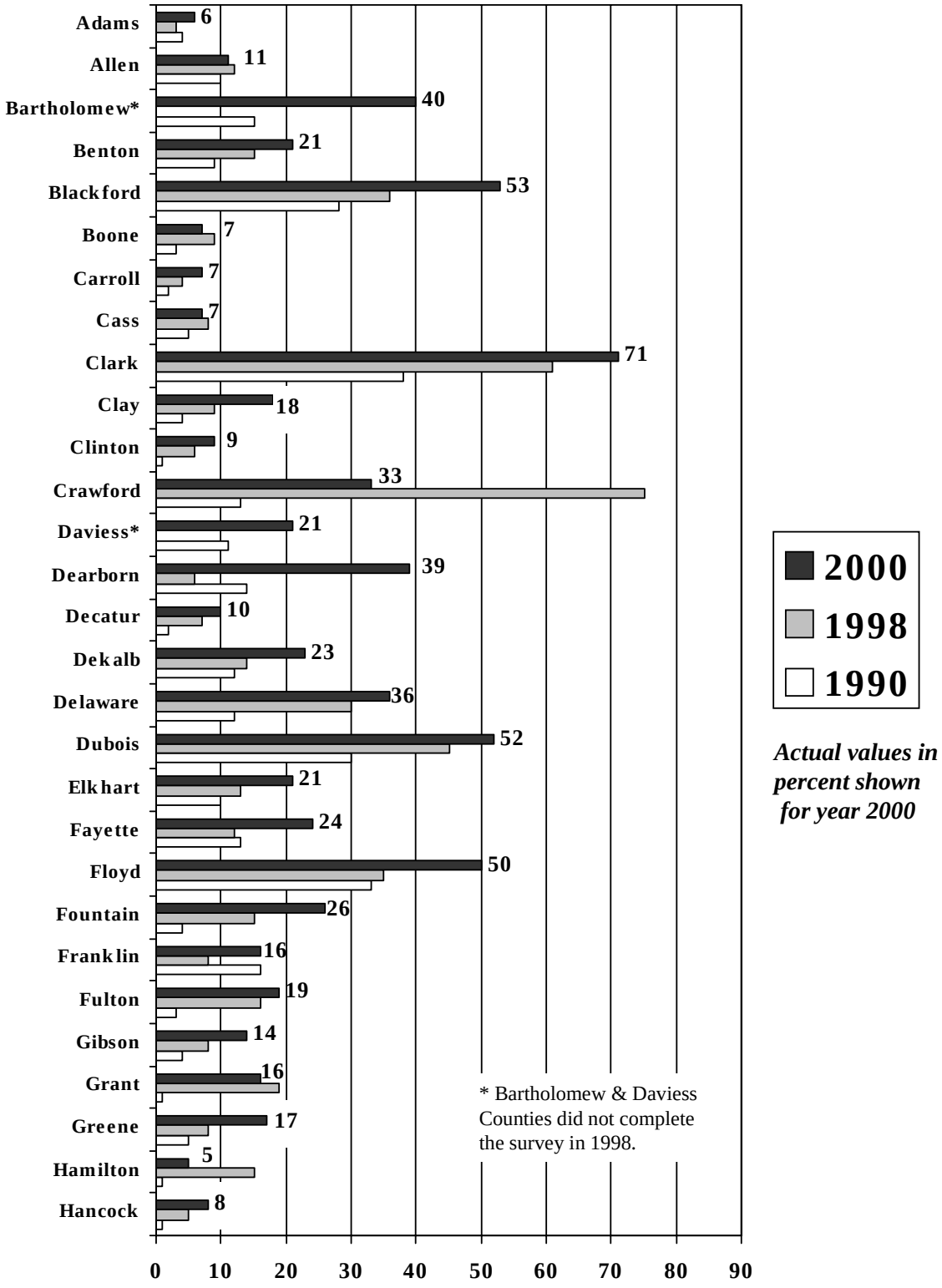
County	Rank	Percent Corn Planted No-till
Scott	1	79
Harrison	2	76
Switzerland	2	76
Washington	4	75
Clark	5	71
Spencer	6	68
Jefferson	7	63
Orange	8	55
Perry	9	55
Blackford	10	53
Wayne	10	53
Dubois	12	52
Steuben	12	52
Floyd	14	50
Jackson	15	49
Owen	16	48
Pike	17	47
Putnam	17	47
Monroe	19	45
Warrick	20	43
Bartholomew	21	40
Dearborn	22	39
Hendricks	23	38
Huntington	23	38
Delaware	25	36
Lawrence	25	36
Martin	27	34
Noble	27	34
Crawford	29	33
Ripley	29	33
Jennings	31	30
Morgan	31	30
Ohio	31	30
Randolph	31	30
Knox	35	28
Montgomery	35	28
Lake	37	27
Shelby	37	27
Fountain	39	26
Fayette	40	24
De Kalb	41	23
Whitley	41	23
Benton	43	21
Daviess	43	21
Elkhart	43	21
Kosciusko	43	21
Jasper	47	20
Sullivan	47	20
White	47	20
Fulton	50	19
Clay	51	18
Greene	52	17
Henry	52	17
Pulaski	52	17
Union	52	17
Vanderburgh	52	17
Franklin	57	16
Grant	57	16
Parke	57	16
St. Joseph	57	16
Tippecanoe	61	15
Gibson	62	14
Jay	62	14
Madison	62	14
Posey	65	12
Allen	66	11
Lagrange	66	11
Newton	66	11
Rush	66	11
Decatur	70	10
Vigo	70	10
Wells	70	10
Clinton	73	9
Porter	73	9
Vermillion	73	9
Hancock	76	8
Warren	76	8
Boone	78	7
Carroll	78	7
Cass	78	7
La Porte	78	7
Adams	82	6
Starke	82	6
Hamilton	84	5
Johnson	84	5
Miami	84	5
Howard	87	4
Wabash	88	3
Tipton	89	0

Percent of Soybean Planted using a No-till System, Rank by County, 2000

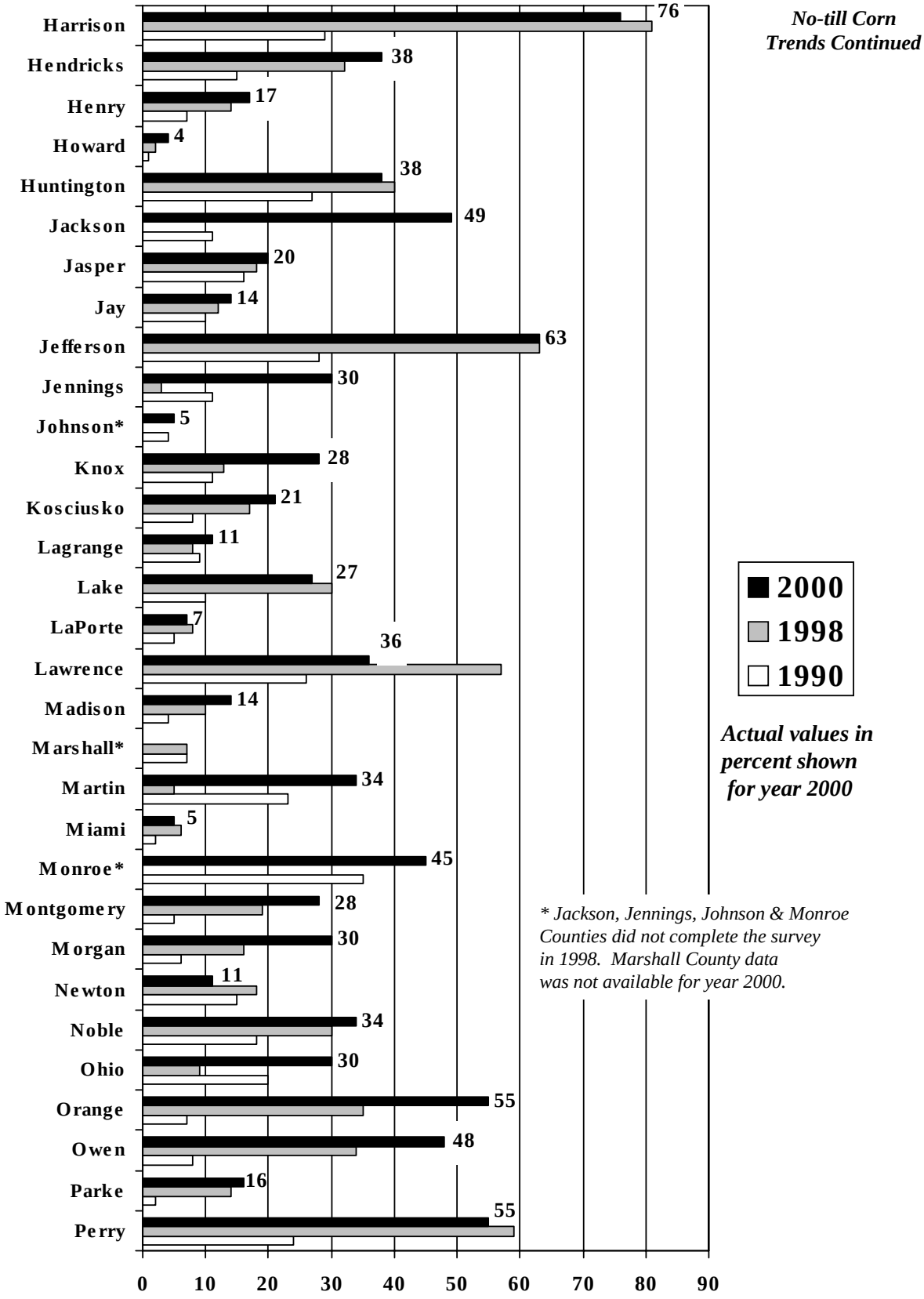
County	Rank	Soybean Planted No-till (%)	County	Rank	Soybean Planted No-till (%)
Harrison	1	91	Jackson	45	62
Scott	2	89	Jennings	47	61
Switzerland	2	89	Monroe	47	61
Clark	4	86	Tippecanoe	47	61
Madison	5	83	Perry	50	60
Randolph	5	83	Benton	51	59
Putnam	7	82	Clinton	52	57
Shelby	7	82	Newton	52	57
Floyd	9	81	Clay	54	56
Blackford	10	80	Owen	54	56
Delaware	10	80	Fayette	56	55
Henry	10	80	Warrick	56	55
Ohio	10	80	Lawrence	58	54
Montgomery	14	79	Pulaski	58	54
Huntington	15	78	Vermillion	58	54
Noble	15	78	Wabash	58	54
Steuben	15	78	Kosciusko	62	53
Wayne	15	78	Lagrange	62	53
Jefferson	19	77	Vigo	62	53
Whitley	19	77	Sullivan	65	51
De Kalb	21	75	Johnson	66	50
Boone	22	74	Elkhart	67	48
Hancock	22	74	Pike	67	48
Bartholomew	24	73	Gibson	69	45
Jay	25	72	Decatur	70	44
Spencer	26	72	Miami	70	44
Fountain	27	71	White	70	44
Washington	27	71	Posey	73	43
Ripley	29	70	Tipton	73	43
Dubois	30	69	Fulton	75	42
Grant	30	69	Porter	75	42
Dearborn	32	68	Greene	77	41
Union	32	68	Jasper	77	41
Hendricks	34	67	St. Joseph	77	41
Franklin	35	66	La Porte	80	40
Lake	35	66	Howard	81	39
Wells	35	66	Martin	81	39
Orange	38	65	Cass	83	34
Parke	38	65	Crawford	84	30
Rush	38	65	Starke	84	30
Warren	38	65	Daviess	86	26
Allen	42	64	Knox	86	26
Adams	43	63	Carroll	88	17
Morgan	43	63	Vanderburgh	89	15
Hamilton	45	62			

No-till Corn Trends for Indiana Counties

(percent of all corn acres planted in a no-till system)

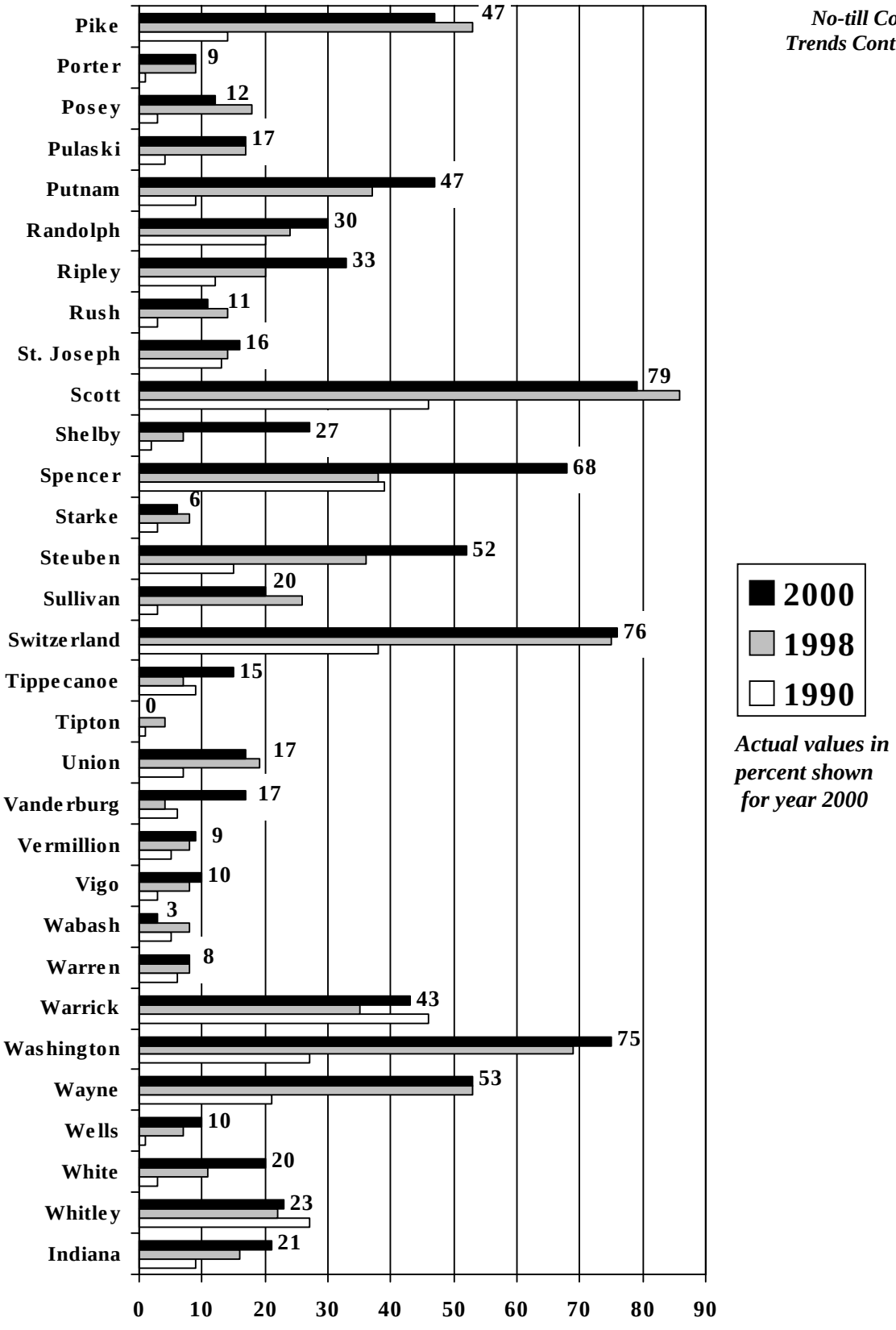


NT Corn


No-till Corn
Trends Continued
Harrison 76
Hendricks 38
Henry 17
Howard 4
Huntington 38
Jackson 49
Jasper 20
Jay 14
Jefferson 63
Jennings 30
Johnson* 5
Knox 28
Kosciusko 21
Lagrange 11
Lake 27
LaPorte 7
Lawrence 36
Madison 14
Marshall*
Martin 34
Miami 5
Monroe* 45
Montgomery 28
Morgan 30
Newton 11
Noble 34
Ohio 30
Orange 55
Owen 48
Parke 16
Perry 55
0 10 20 30 40 50 60 70 80 90
2000
1998
1990
Actual values in percent shown for year 2000
* Jackson, Jennings, Johnson & Monroe Counties did not complete the survey in 1998. Marshall County data was not available for year 2000.

NT Corn

No-till Corn Trends Continued

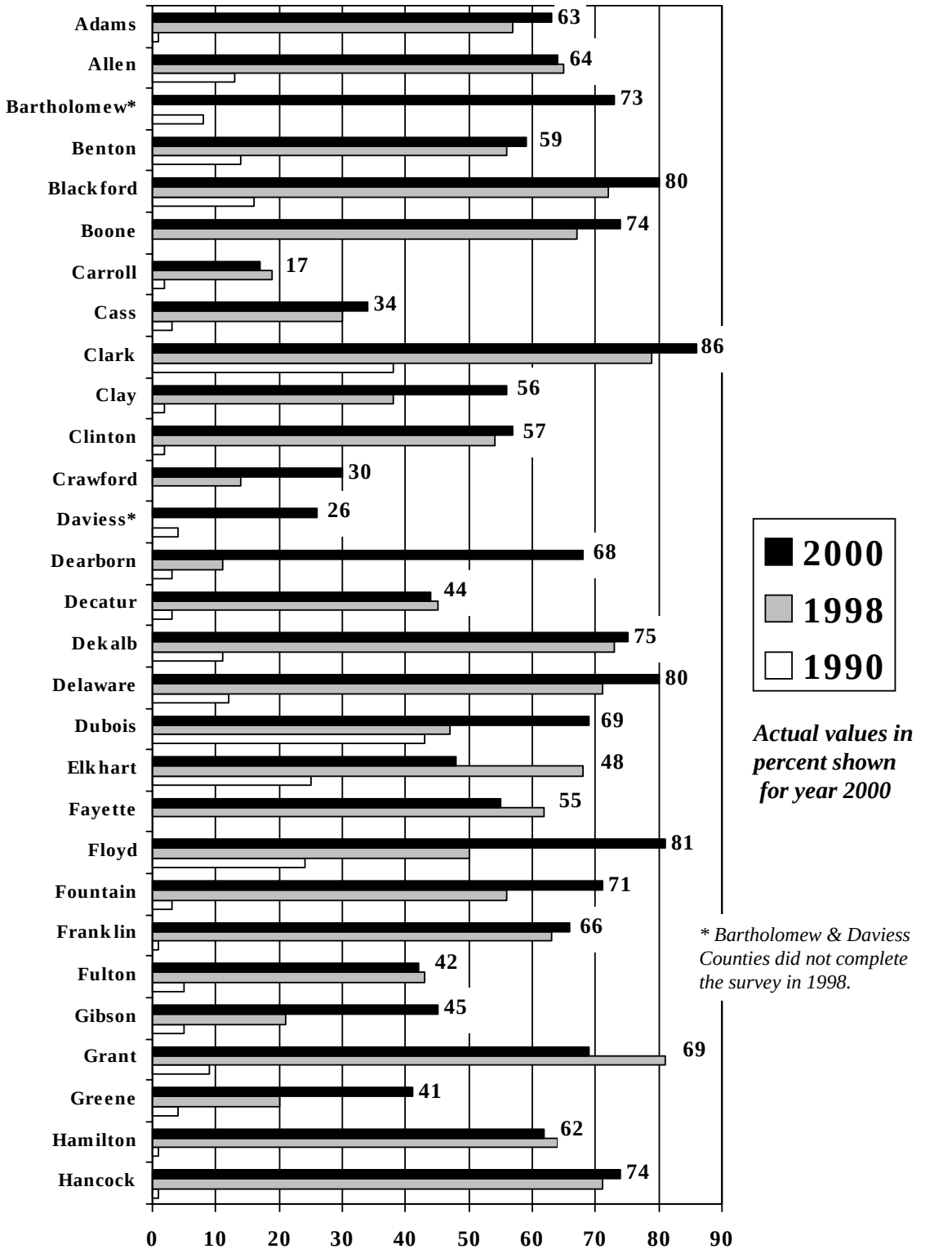


Actual values in percent shown for year 2000

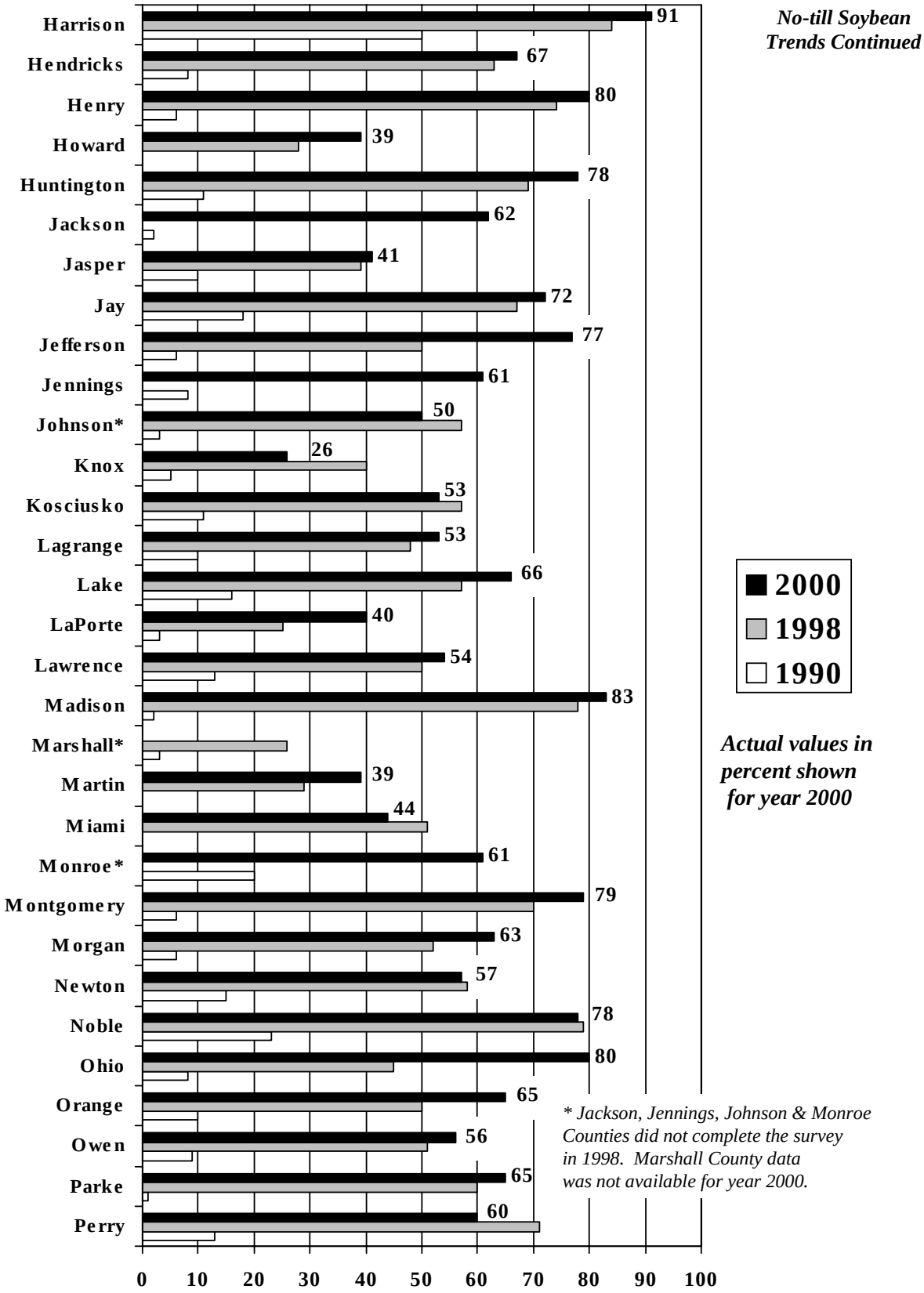
NT Corn

No-till Soybean Trends for Indiana Counties

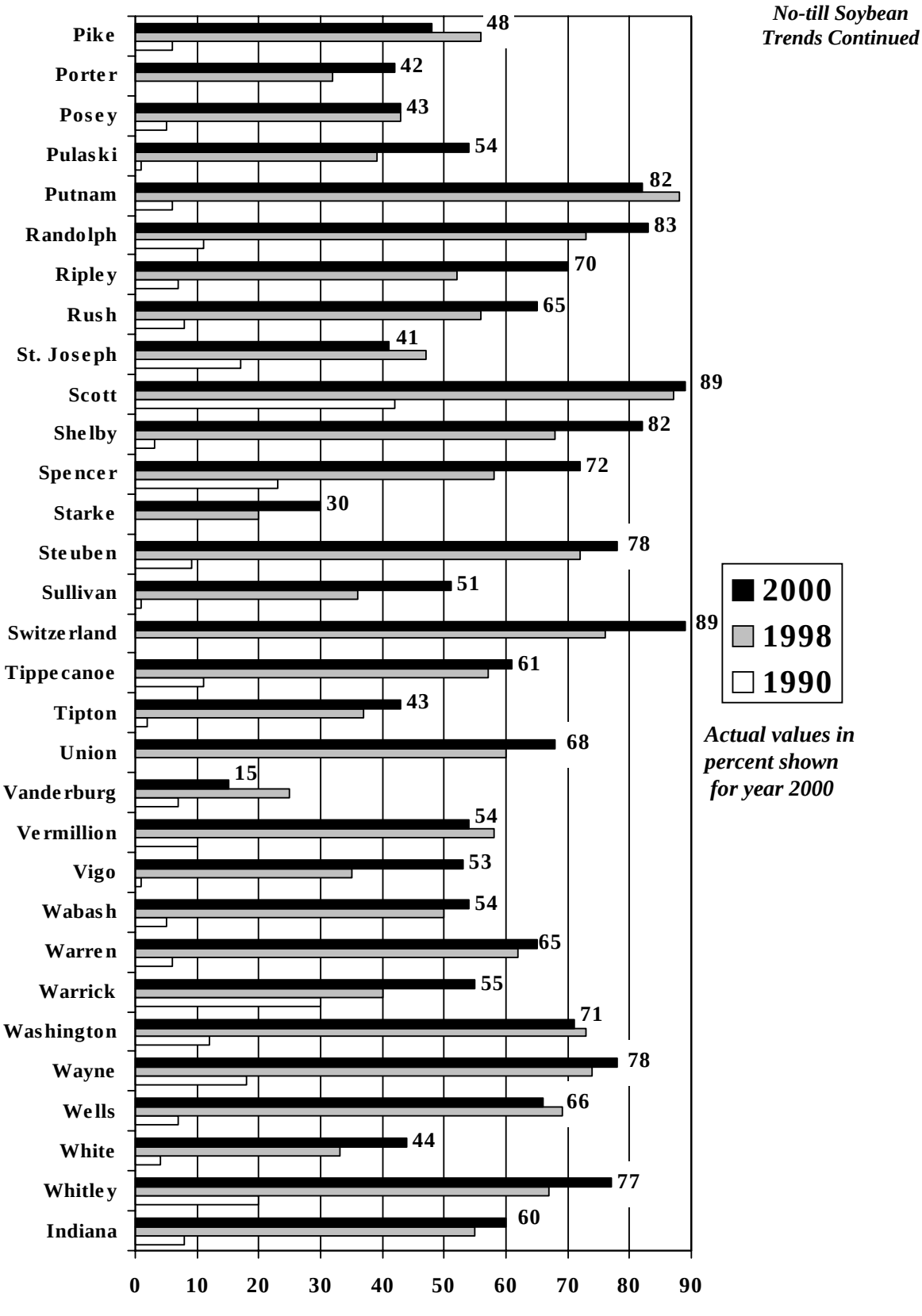
(percent of all soybean acres planted in a no-till system)



NT Beans


No-till Soybean Trends Continued
Harrison 91
Hendricks 67
Henry 80
Howard 39
Huntington 78
Jackson 62
Jasper 41
Jay 72
Jefferson 77
Jennings 61
Johnson* 50
Knox 26
Kosciusko 53
Lagrange 53
Lake 66
LaPorte 40
Lawrence 54
Madison 83
Marshall*
Martin 39
Miami 44
Monroe* 61
Montgomery 79
Morgan 63
Newton 57
Noble 78
Ohio 80
Orange 65
Owen 56
Parke 65
Perry 60
0 10 20 30 40 50 60 70 80 90 100
2000
1998
1990
Actual values in percent shown for year 2000
* Jackson, Jennings, Johnson & Monroe Counties did not complete the survey in 1998. Marshall County data was not available for year 2000.

NT Beans


No-till Soybean Trends Continued
Pike 48
Porter 42
Posey 43
Pulaski 54
Putnam 82
Randolph 83
Ripley 70
Rush 65
St. Joseph 41
Scott 89
Shelby 82
Spencer 72
Starke 30
Steuben 78
Sullivan 51
Switzerland 89
Tippecanoe 61
Tipton 43
Union 68
Vanderburg 15
Vermillion 54
Vigo 53
Wabash 54
Warren 65
Warrick 55
Washington 71
Wayne 78
Wells 66
White 44
Whitley 77
Indiana 60
0 10 20 30 40 50 60 70 80 90
2000
1998
1990
Actual values in percent shown for year 2000
NT Beans

Indiana No-till Corn After...

Year	Corn	Soybean	Small Grain	Forages	Other
1990	26%	44%	7%	4%	17%
1993	24%	62%	6%	2%	6%
1996	20%	69%	6%	2%	3%
1998	13%	76%	5%	3%	3%
2000	9%	84%	3%	1%	3%

Indiana No-till Soybean After...

Year	Corn	Soybean	Small Grain	Forages	Other
1990	66%	11%	5%	1%	15%
1993	86%	10%	2%	0%	2%
1996	79%	14%	5%	1%	1%
1998	86%	10%	2%	1%	1%
2000	87%	10%	1%	1%	1%

any other method of conservation tillage. Furthermore, USDA has placed greater focus on filter strip, grassed waterway and buffer program objectives than on conservation tillage objectives. Certainly farmers have not given conservation tillage—especially no-till— the "continuous" time necessary to reap yield and economic benefits. Data from the Purdue Agronomy Research Center show that over the past 25 years, no-till used in a corn-soybean rotation economically outperformed conventional, mulch and strip tillage systems. [3] Perhaps a program to entice farmers to stay with no-till longer term could benefit both farmers and society in general.

2000 No-till in Corn Belt States

State	No-till Corn (%)	No-till Soybean (%)
Illinois	17	42
Indiana	***21***	***60***
Iowa	18	27
Kentucky	54	59
Michigan	14	39
Missouri	24	37
Nebraska	25	21
Ohio	24	61
USA	18	31

Most of Indiana's no-till acres are in a corn-soybean rotation. For no-till corn, 84 percent was planted after soybean in 2000 compared to 44 percent in 1990. For no-till soybean, 87 percent was planted after corn compared to 66 percent in 1990. No-till soybean after soybean was consistently around 10 percent during the period 1990 to 2000, while no-till corn after corn dropped from 26 percent in 1990, to nine percent in 2000.

Nationally, 17.5 percent of all U.S.

cropland was no-tilled in 2000. By crop nationally, no-till was used on 18 percent of all corn acres and 31 percent of all full season soybean acres.

Cropland Use

Indiana's land area consists of approximately 23 million acres. In 1998, Indiana's cash receipts ranked 4th in the U. S. for both corn and soybean production representing 8.3 and 8.6 percent, respectively, of all U.S. cash receipts for these grains [5]. Annual planted cropland represents more than one-half of Indiana's landscape. Based on the tillage survey in 2000, Figure 2 shows how Indiana cropland was used.

Figure 2.

Indiana Cropland Use, 2000

Crop	Land Area
Corn	43%
Soybean (Total)	41%
Drilled Soybeans	33%
Narrow Row Soybean	5%
Wide Row Soybean	3%
Small Grain	4%
Hay	8%
Fallow	1%
CRP	1%

Given the large area of Indiana used for cropland, the fact that 45 percent of this cropland is under conservation tillage has a significant impact on water quality and reductions in soil erosion.

Soil Loss

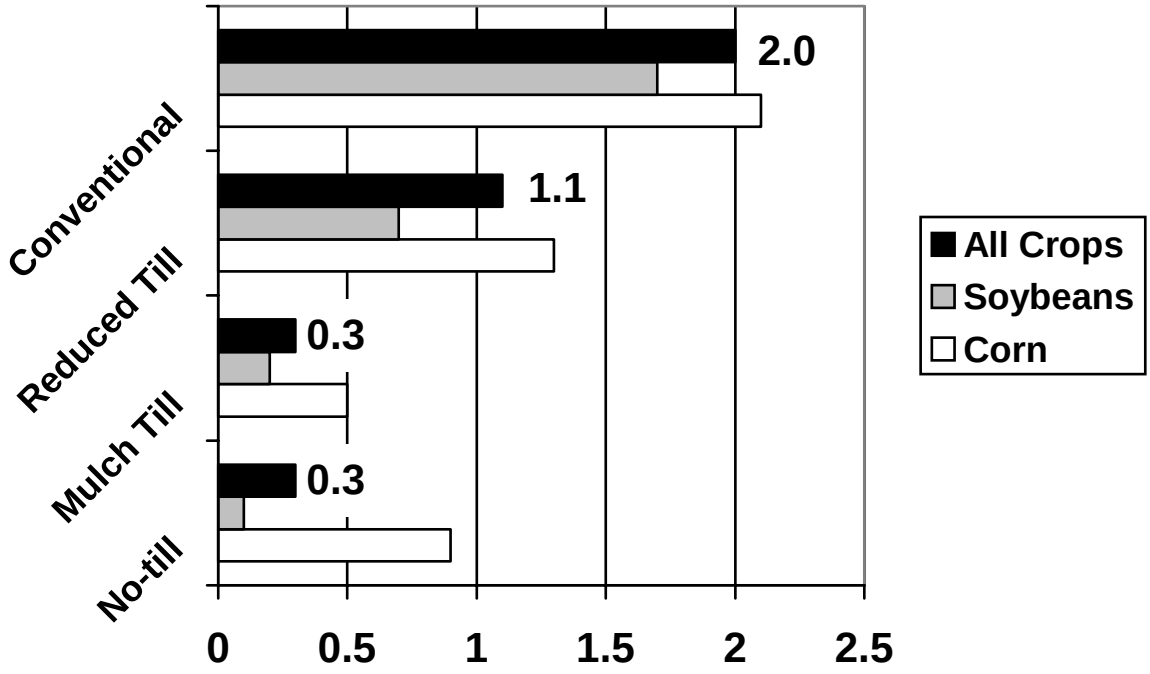
The terminology "soil loss in relation to T" refers to the "tolerable" amount of soil that can be lost while maintaining the productivity of the soil through natural formation processes. Most Indiana soils have a T value of three to five tons per acre per year. To provide perspective, five tons of soil spread evenly over an acre would only be the thickness of a dime. A ton of soil would fit approximately into a 30 inch cube. Therefore one serious storm event

"By volume, soil erosion and runoff is typically the greatest contaminant of surface water in Indiana"

and unprotected soil could spell disaster. The best method to protect soil is to keep the surface covered and minimize disturbances. As a result of conservation tillage, 75 percent of Indiana's cropland is losing soil at or below the tolerable level of T for the 2000 growing season. Although agriculture uses more land area than urban use, it is important to note that urban development like road and building construction can result in significant soil erosion resulting in degradation of water quality.

The average Universal Soil Loss Equation (USLE) soil loss in 2000 on conventional tilled fields was 5.3 tons per acre compared to 1.6 tons per acre for all no-till fields. Figure 3 illustrates soil loss in relation to T by tillage. Conventional tillage consists of any tillage/planting system with 0-15 percent residue cover after planting. Reduced tillage consists of any tillage/ planting system with 15-30 percent residue cover after planting. Mulch tillage is any other system besides no-till and ridge-till

Figure 3. Indiana USLE Soil Loss in Tons/A in Excess of T by Tillage System, 2000



that leaves more than 30% residue cover. Figure 3 does not take into account the location of the specified crop or tillage system in relation to topography or soil type. This may explain the greater soil loss in relation to "T" for no-till corn compared to mulch-till corn. There were nearly six times more no-till fields than mulch-till fields on strongly sloping soils.

Summary

More than one-half of Indiana's landscape is used to grow annual crops. The use of conservation tillage on this cropland is vital to maintaining the productivity of the soil and improving surface water quality. Farmers benefit from conservation tillage through reduced production costs and therefore have the potential for increased profit margins. Both farm and non-farm residents benefit from conservation tillage through cleaner surface water for drinking, recreation and other uses. Wildlife also benefit from the reduced runoff, cleaner water and the habitat provided, particularly in no-till fields.

Since 1990, the overwhelming adoption of conservation tillage has resulted in the accomplishment of 75 percent of the state losing soil at or below "T" (the tolerable level of soil loss). For most Indiana soils, "T" is three to five tons per year and is the rate that new soil can be formed. While soil conservation has come a long way in Indiana, there continues to be more than 3 million acres losing soil at a rate faster than "T" and in need of conservation practices.

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